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MARKET DISEASES OF FRUITS AND VEGETABLES:

PEACHES, PLUMS, CHERRIES AND OTHER STONE FRUITS

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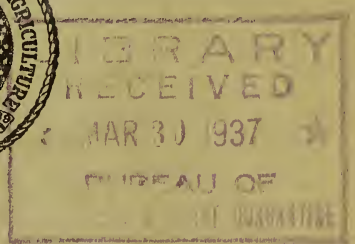

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MARKET DISEASES OF FRUITS AND VEGETABLES

PEACHES, PLUMS, CHERRIES, AND OTHER STONE FRUITS [1]

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ALTERNARIA ROT (GREEN MOLD ROT)

(*Alternaria* sp.)

OCCURRENCE, SYMPTOMS, AND EFFECTS

Alternaria rot is one of the common diseases of cherries on the market, although it is seldom the most destructive. It occurs on all of the principal varieties of sweet cherries from California and the

[1] This publication is the fourth in a series designed to aid in the recognition and identification of pathological conditions of economic importance affecting fruits and vegetables in the channels of marketing, to facilitate the market inspection of these food products, and to prevent losses from such conditions. It represents an extended revision and elaboration, with the addition of colored illustrations, of a preliminary (multigraphed) Handbook of Diseases of Fruits under Market, Storage, and Transit Conditions, prepared in 1919 by Dean H. Rose and the late O. F. Burger for the use of the food-products inspectors of the Bureau of Agricultural Economics. The material is organized on the basis of the botanical families to which the plants belong, but no botanical system is followed in arranging these families. Practical considerations make it desirable to issue the material in separate sections arranged somewhat in the order of the economic importance of the crops. The Host Index of the Fungi of North America, by A. B. Seymour, 1929, is used in the main as a guide to the nomenclature of causal fungi and the names of authorities therefor. The common names of the insects mentioned are those approved for general use by the American Association of Economic Entomologists. The statements regarding fruit injuries caused by insects are made with the approval of the Bureau of Entomology and Plant Quarantine. B. A. Porter, of that Bureau, has collaborated with the authors in the preparation of the entomological portions of the publication. The colored plates are reproduced from water-color paintings by L. C. C. Krieger, R. C. Steadman, Mary D. Arnold, and J. Marion Shull, of the Bureau of Plant Industry, under the direction of Dean H. Rose, and from colored photographs prepared through the collaboration of Webster Bros., Chicago, Ill., under the direction of Dean H. Rose, D. F. Fisher, Charles Brooks, C. O. Bratley, and the late O. F. Burger.

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Northwest and has been found on sour cherries from Michigan. It has occasionally been found on the market on western plums and peaches.

The rot usually occurs as a firm, dark-brown, slightly moist spot in the shape of a cone with its apex extending toward the pit. This dark-brown to black mass is made up of dead tissue, interpenetrated and apparently held together by the mycelium of the organism. It is much firmer than the surrounding healthy tissue, so that if the skin is carefully broken around the spot the decayed tissue can be lifted out intact. The skin on the affected area is covered with dusky olive-green sporulating hyphae,[2] which are frequently hidden beneath a layer of white fluffy mycelium. On very small spots the aerial mycelium may be hyaline.

This decay is quite similar to cladosporium rot, also called "green mold" rot, and often cannot be distinguished from it with certainty except by microscopic examination. In the case of alternaria rot, however, the surface mold is darker in color, the decayed tissue is moister and darker, and the enlargement of the lesions is more rapid.

Certain decays with the typical dark mycelium of *Alternaria* are only skin-deep, but may cover half of the cherry with little more than this surface mold. Apparently this type of decay follows bruising of the cherry with some escape of juice. It is more frequently reported on sour than on sweet cherries.

CAUSAL FACTORS

The decay is induced by a fungus of the genus *Alternaria*, the species of which has not been determined. Possibly more than one species of the organism is capable of producing the characteristic symptoms. The fungus enters the cherry through breaks in the skin, either mechanical wounds received during picking and packing or cracks caused by excessive moisture just before picking. The source of inoculum is not known, but probably this fungus, like other members of its genus, lives over winter on dead material in the orchard.

CONTROL MEASURES

Since the fungus enters through wounds, care in handling will reduce the decay. After penetrating the fruit, the fungus produces decay over a wide range of temperatures, with the most rapid development at 85° F. The decayed areas continue to enlarge slowly at temperatures as low as are found in the ordinary type of refrigerator car. Rapid cooling after picking is important for control. (*38*.)[3]

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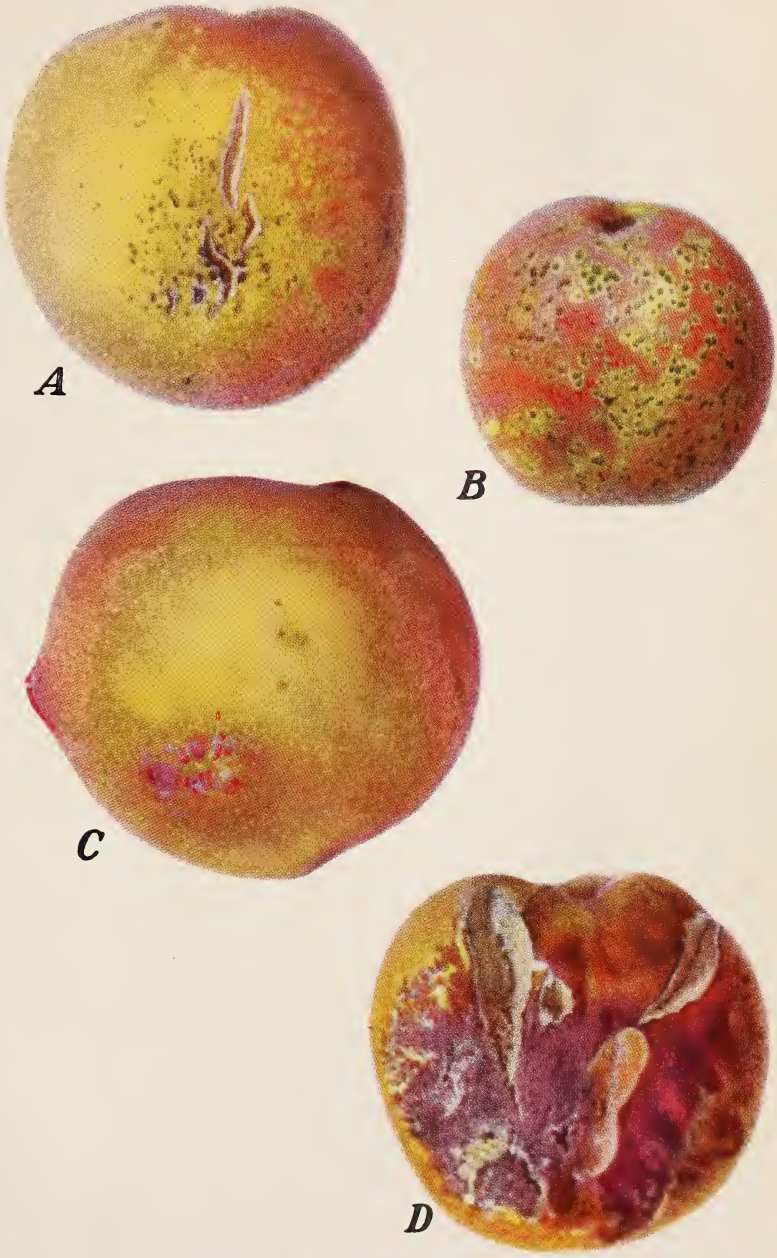
[2] Important characters common to the fungi discussed in this publication are a mycelium consisting of fine threads called "hyphae", and minute bodies known as "spores", which serve the purpose of seeds. The spores may be produced on specialized branches of the mycelium or in fruiting bodies of various kinds. When carried by wind, insects, or other agencies they may lodge on any exposed plant parts throughout the orchard, many of them of course on the fruit. With spores present on the fruit, conditions that lead to decay or other diseased conditions either in the field or in transit are as follows: Moisture on the fruit surface, skin breaks, which furnish easy entrance for the fungus, and temperatures of 50° F. or above, without which infection takes place very slowly if at all. Other details concerning the effect of temperature on fungus growth will be given under the various diseases. See also introduction to Miscellaneous Publication 168, Market Diseases of Fruits and Vegetables: Apples, Pears, Quinces.

[3] Italic numbers in parentheses refer to Literature Cited, p. 23.



A, Bacterial spot of peach; *B*, scab of peach; *C*, *D*, leaf curl of peach

BACTERIAL SPOT

(*Bacterium pruni* (E. F. Smith) E. F. Smith[4])

OCCURRENCE, SYMPTOMS, AND EFFECTS

Bacterial spot is an orchard disease which affects fruits, twigs, and leaves of the peach, apricot, nectarine, and plum. On all of these it causes most damage by its attack on the leaves, because of excessive defoliation and consequent devitalizing of the tree. However, it often blemishes the fruit so badly that the market value of the crop is greatly reduced.

This disease has been reported from practically all peach sections of the eastern United States. It is usually more serious in southern fruit-growing sections, but is sometimes seen as far north as Iowa, Michigan, and New York. All varieties of peaches are susceptible to its attack, though of the more important commercial varieties, J. H. Hale, Elberta, Carman, Sneed, and Champion generally suffer more damage than do Hiley, Belle, Early Crawford, and Salwey. The varieties of nectarines most severely affected are New White, Stanwick, and Victoria. American varieties of plums are rarely attacked, whereas the Japanese varieties, especially Abundance and Burbank, often show serious injury. Royal, one of the chief commercial varieties of apricots, is quite susceptible to the spot.

Symptoms of the disease are similar on all varieties of stone fruits, the chief difference being that they are more pronounced on some than on others. On the leaves the first symptoms are shown as small, nearly transparent, water-soaked areas which later turn dark, become dry and brittle, and finally fall out, producing the shot-hole appearance which has given rise to one of the names applied to this disease. On the twigs the affected spots appear in their final stage as slightly sunken purplish-black to black areas, half an inch to 2 inches in length, and extending half to two-thirds the way around the twig.

On the fruit the disease shows first as small, circular, faint brown spots which later enlarge and grow darker. As the disease progresses affected tissues dry out and crack, the cracks becoming so marked in later stages, when they deepen and run together, that they constitute a serious blemish and sometimes render the fruit unmarketable (pl. 1, *A*). On peaches and nectarines, where the cracking is most severe, it is occasionally followed by infection with blue mold and other decay fungi.

CAUSAL FACTORS

Bacterial spot, caused by *Bacterium pruni*, was first described in 1902 on Japanese plums but has since been found on all stone fruits except cherries. The latest and most extensive investigations (*20*) indicate that the bacteria overwinter in cankers on the twigs and are spread from these in the spring and early summer when the bacterial ooze drips or is splashed onto leaves and fruit below by drops of rain or dew. The bacteria exuding from leaf and fruit spots constitute a secondary source of infective material which is believed to

[4] Syn., *Phytomonas pruni* (E. F. Smith) Bergey et al.

be distributed in the same way. Wind is also thought to be a factor in the distribution of the pathogene, since it causes a wider scattering of rain or dew drops than would occur in still air.

CONTROL MEASURES

In sections where the disease is not severe and the soil is relatively fertile, bacterial spot can be kept under commercial control by proper pruning, cultivation, and the use of fertilizers, especially nitrate of soda, all of these being practices that tend to keep the trees vigorous and healthy. Where these measures fail, spraying with zinc-lime combination has often proved effective in reducing defoliation and increasing the percentage of marketable fruit. (*1*, *4*, *5*, *20*, *32*, *52*.)

BLACK MOLD ROT

(*Aspergillus* sp., probably *A. niger* Van Tiegh.)

Black mold rot of peaches and cherries has been reported only from the West, chiefly from California. So far as known, the fungus may attack any variety, but there is no record of its having caused serious loss at any time.

The lesions it produces on peaches are small and shallow. There is slight browning of the affected flesh and practically always a scanty growth of the fungus on the surface. Before spore production begins this is merely a white mycelium not readily distinguishable from that of gray mold. After spores are produced, in the characteristic black or purplish-black clumps, the white is masked and the growth has a sooty appearance. On sweet cherries a watery, mushy rot is produced which can be scooped out, leaving a clean hollow in the surrounding flesh. The epidermis covering the spot usually shows several cracks through which the fungus appears in small, white tufts that later turn jet black with the production of sooty spore masses. This decay is important only on fruit held at high temperatures. Nothing is known of when or how infection takes place nor of how it can be prevented.

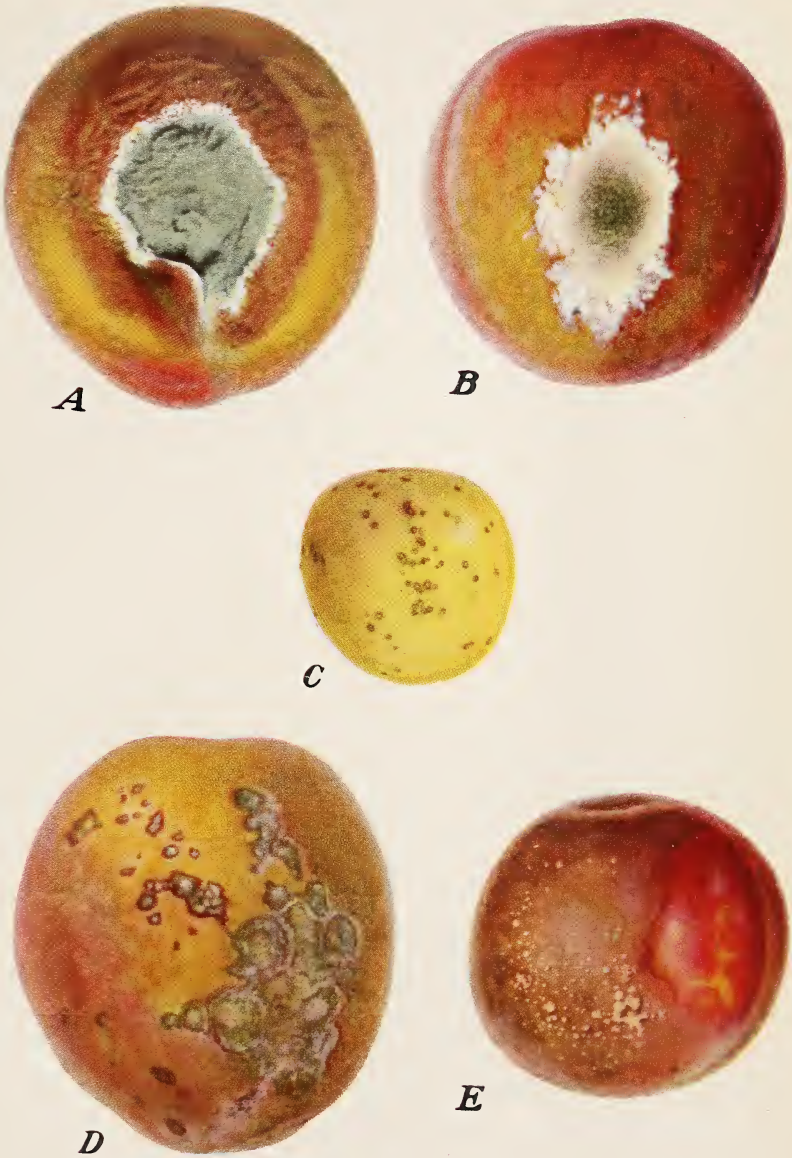
BLUE MOLD ROT

(*Penicillium* sp.)

OCCURRENCE, SYMPTOMS, AND EFFECTS

Blue mold rot occurs on all kinds of stone fruits but is more common on cherries and plums than on peaches or apricots. On the two former fruits it is more destructive during the marketing process than any other rot except possibly rhizopus rot. It rarely affects any of the stone fruits on the tree.

In early stages on cherries the rot is characterized by a circular flat area covering a conical decayed spot of very soft and watery light-brown tissue. The decayed mass can be scooped out cleanly from the surrounding healthy tissue. The skin covering the spot cracks readily, and through the cracks small, white, tufted cushions of the fungus grow (pl. 6, *D*). Under humid conditions the spot may be entirely covered with a scanty growth of mold, white at



A, Blue mold rot of peach; *B*, gray mold rot of peach; *C*, physiological spot or "scab" of apricot; *D*, California blight on peach; *E*, brown rot of plum.

fruits as well. It will be considered here only in reference to stone fruits.

Brown rot originates in the orchard but may cause damage at any stage of the marketing process or even after the fruit reaches the consumer. In the orchard it occurs on leaves, blossoms, fruits, twigs, and limbs, the completeness of the attack depending to a considerable degree on which of the stone fruits is affected and on temperature and moisture conditions.

The disease on the fruit appears at first as small, circular, light-brown spots, which under conditions favorable to infection (at temperatures of 60° to 80° F.) may enlarge so rapidly as to bring about complete decay in 24 hours. The spots at no stage are sunken, and the flesh remains firm. In late stages the skin turns dark brown or even black. The easily observed yellowish-gray masses on the surface of rotted spots are composed of millions of spores, which are able to start the disease again on other fruits (pl. 3, *A*, *B*). In early stages the rot on cherries is brown of a considerably lighter color value than that of the normal fruit; later this brown gradually darkens and the margin of the lesion fades into the normal flesh color, leaving no distinct line separating decayed from healthy tissue. The skin covering the lesion remains firmly attached to the tissue beneath (pl. 6, *C*, *G;* pl. 9, *B*). The characteristics of the rot on plums are similar to those on peaches (pl. 2, *E;* pl. 8, *D*).

In the Eastern and Southern States and in the humid sections of Washington and Oregon, brown rot occurs on all stone fruits; in California it is found chiefly on apricots and cherries. It sometimes occurs in California peach orchards but is only occasionally severe on the market on peaches from that State.

CAUSAL FACTORS

The fungus that causes brown rot (*Sclerotinia fructicola* (Wint.) Rehm) winters over chiefly on mummies adhering to the branches and on rotted fruit that falls to the ground; it also winters over to a slight extent on twig and limb cankers. During wet weather in the growing season it produces immense numbers of spores on mummies, on infected blossoms, and on twig and limb cankers. The spores find lodgment everywhere but are of greatest importance on the blossoms and fruits, which are very susceptible to attack. Diseased blossoms and twig cankers are an important source of infection in prune and cherry orchards.

The development and spread of the disease in the orchard, particularly on the fruit, are closely associated with warm, wet weather, although a prolonged drizzly spell or a series of cloudy days with frequent showers is more dangerous than a heavy rain followed by clearing. But since summer temperatures in any stone-fruit section are usually well above the minimum required for the development of brown rot, the chief determining factor in all sections is moisture. Immature fruit is less susceptible than fully ripened fruit.

Breaks in the skin due to careless handling, to wind whipping or hail, to insect injury, or to the cracking that often accompanies scab, all tend greatly to increase infection. In fact, without skin breaks there is little danger of infection, except under favorable conditions of moisture and temperature, as, for example, in the

A, Brown rot of peach; *B*, brown rot of peach, longitudinal section; *C*, rhizopus rot of peach; *D*, rhizopus rot of peach, longitudinal section.

upper layers of a carload, where the fruit may be too warm for 12 hours or more. Under such conditions the fungus is apparently able to penetrate the uninjured skin of the fruit and may spread from one fruit to another by contact.

Chief among insects associated with brown rot or concerned in the distribution of brown-rot spores is the plum curculio (p. 17). When the curculio and the rot occur in the same fruit, infection probably took place at the egg-laying puncture through spores carried either by the insect or lodged there by the wind. When the rot occurs alone, infection may have taken place at a curculio feeding puncture or some other skin break, or directly through the otherwise sound, undamaged skin. Injuries caused by the oriental fruit moth (p. 16) frequently become infected with the rot. In the Northwest, stone fruits grown west of the Cascade Mountains sometimes become infected with brown rot at injuries made by the syneta leaf beetle.

CONTROL MEASURES

Brown rot can usually be controlled in the orchard by some form of sulphur combined with a suitable insecticide (for the control of curculio, see p. 17). For details, the United States Department of Agriculture or the State experiment stations should be consulted. Dusting stone fruits with sulphur shortly before harvest is decidedly effective in improving their carrying quality.

Before discussing the control of brown rot in transit it is desirable to consider the more important factors that favor the occurrence of the rot in transit. The statements made are applicable to any of the stone fruits.

Growers and shippers find that different shipments of their fruit often arrive in different condition at the market even though they have used the same methods of picking and packing, have shipped fruit of the same variety, and the shipments have had what seemed to be the same conditions in transit. If the identity in treatment really exists, the difference in final condition is usually a matter of weather at the shipping point. It may occasionally be due to difference in maturity.

In brown-rot territory, if wet weather prevails when the crop is harvested, the disease and the spores of the fungus will be abundant in the orchard. Consequently, some fruits with small rotten spots are likely to be overlooked by the packers; or fruit may be packed in which infection actually exists, but not at such a stage that it is visible as discolored spots; or, as a third possibility, fruit may be packed on which spores have lodged but have not yet caused infection. If conditions in transit are favorable, the rotten spots already present (whether visible or not) will enlarge, new ones will be formed by the germination of spores lodged on the fruit, and the load will arrive at destination showing decay.

If the weather is dry at picking time, brown-rot spores will be scarce on the fruit and there will be little or no fruit infection, either visible or invisible; consequently the chances are good that very little decay will develop in transit, even under conditions that might allow much of it if the fruit had been picked during wet weather.

Peaches harvested in brown-rot territory in wet weather are not necessarily sure to rot in transit under good conditions. However, it

is true that too often the conditions under which the crop is handled and moved to market are not such as to hold brown rot in check. Frequently there is not sufficient care and expedition in picking and packing. In transit there is usually moisture enough present for spore germination, so that development and spread of the rot depend mainly on temperature. New infection is almost entirely prevented by temperatures below 50° F., and the development of rot already present is checked somewhat at 50° and to a still greater extent the lower the temperature goes; but the fungus when already established is able to make some progress even at 32°. The upper limit of safety, that is, the temperature that will prevent serious loss during the ordinary transit time, is about 45°.

If fruit is loaded hot, say with a temperature of 80° or 90° (or even higher, as sometimes happens), it may take 24 to 48 hours to cool below 50°, even though it is moving in a car with bunkers iced to capacity at all icing stations while en route to market. Such a delay in cooling and similar delays due to belated or otherwise faulty icing of the car give time for old infections to enlarge or new ones to start and are responsible for much of the loss that this disease causes on fruit in transit. Delays in the movement of the car may also increase the loss, by giving the brown-rot fungus a longer time in which to work.

Brown rot, like numerous other rots, is practically always worse at the top of the load than at the bottom. The temperature at the top is often 5° to 10° and occasionally 20° higher. It is evident, therefore, that the higher temperature at the top causes the rot to develop more rapidly, and that the lower temperature at the bottom holds it in check. Differences in temperature between the top and the bottom of the load are found, however, in both well-iced and poorly iced shipments. When the difference is small it should be considered merely the result of the way in which cooling takes place in refrigerator cars; when large it may mean any one or a combination of the following: (1) A poorly constructed car, (2) a car in need of repair, (3) inadequate transit icing, or (4) improper stowing of the load, which interferes with air circulation.

Precooling either before loading or by means of an apparatus that reverses the air circulation in the car is usually very beneficial. Precooling in the car reduces the difference in temperature between top and bottom of the load, and while it hastens cooling in all parts of the load, it causes the most rapid cooling in the upper layers. For best results, 2 to 6 hours' precooling in the car, depending on the type of blower used, and the addition of 3 to 4 percent salt to the bunker ice during the precooling should be the practice with moderately warm fruit. If the fruit is hot (90° F. or higher), 3 to 8 hours' precooling, again depending on the type of blower used, and 5 percent salt are needed to bring it to a temperature that will prevent the development of rot. Under either of these conditions there is very little danger of freezing, because practically all of the salt will be used up before precooling is finished. (*2*, *5*, *6*, *7*, *11*, *12*, *13*, *14*, *15*, *18*, *23*, *24*, *30*, *31*, *33*, *36*, *38*, *40*, *42*, *44*, *48*, *49*, *50*, *51*, *53*, *56*, *57*, *58*, *59*, *62*.)[6]

[6] BRATLEY, C. O. See footnote 5.

BRUISING

Bruising may occur on all stone fruits, but is most common on plums and peaches. It may be caused by careless handling in picking or packing, by packing too tightly, too high, or too loosely in the package, or by rough handling in transit. If the bruising is only moderate it blemishes the fruit; if severe it causes skin breaks that let in various decay organisms. The riper the fruit the greater the damage.

Bruises on peaches are sometimes mistaken for rot. To distinguish the two it is only necessary to remember that in bruising the flesh has a mottled brown and white appearance and the skin is not browned, whereas in rotten spots both skin and flesh are brown. The shade of brown varies somewhat with the kind of rot, being considerably darker for brown rot than for either rhizopus rot or blue mold rot.

In packed boxes of sweet cherries, bruises in the form of translucent, brownish discolorations midway between the pit and the skin are frequently found in fruit on the face of packs that show too much bulge and in fruits that have been pressed together in packing. The skin of the cherry above the discoloration appears normal except when the injury has been severe. In loosely packed lugs, cherries of the Napoleon (Royal Ann) variety next to the lid sometimes exhibit a scalded appearance of the skin. This results from the excessive chafing the fruit receives in transit. The bruising and discoloration are not restricted to any one variety of sweet cherries but are most noticeable on the Napoleon because of the light-colored skin and flesh of that variety.[7]

CALIFORNIA BLIGHT

(*Coryneum beijerinckii* Oud.[8])

California blight, also known as "peach blight", "shot hole", "brown spot", "pustular spot", and "winter blight", is a fungus disease which originates in the orchard, where it causes leaf spots and shot-holing, twig and limb cankers, and spotting or rotting of fruit. It occurs rather commonly on peaches in California, Colorado, and Utah, and is sometimes seen on this fruit in Indiana, Michigan, New York, Ohio, and Oregon. The disease also occurs on plums, cherries, and apricots.[9]

Infected spots on peaches are at first purplish-red, small, and distinct from one another. Later, as they enlarge, they have white centers surrounded by brown areas one-eighth to one-fourth of an inch in diameter (pl. 2, *D*), and become slightly sunken. There is evidently some development in transit, because peaches found affected with the disease on the market frequently show lesions much

[7] Bratley, C. O., and Zimmerman, F. S. discoloration of napoleon (royal ann) cherries. U. S. Dept. Agr., Bur. Plant Indus., Plant Disease Reptr. 15 : 110–111. 1931. [Mimeographed.]

[8] Probably synonymous with *Clasterosporium carpophilum* (Lév.) Aderh., according to a personal communication from A. A. Nightingale.

[9] Baines, R. C. coryneum beijerinkii on peach and apricot in indiana. U. S. Dept. Agr., Bur. Plant Indus., Plant Disease Reptr. 19 : 239. 1935. [Mimeographed.]

larger than those common in the orchard; that is, half an inch or more in diameter, and depressed one-eighth to one-fourth inch below the surrounding healthy skin. In some instances the spots on fruit arriving at market are found to have coalesced and formed diseased patches covering a fourth or more of the fruit. Cracks may develop in the diseased areas and are sometimes followed by a flow of gum. Infection with brown rot or rhizopus rot sometimes occurs at the spots, although usually the affected tissues have such a dry, corky texture that decay fungi do not readily attack them. On cherries there are usually only 1 or 2 spots, and in these the fungus causes a drying of the flesh to the stone, or a spreading infection that may involve the whole fruit.

A spotting of apricots known variously as "scab" and "shot hole" (pl. 2, *C*) occurs in California and the Pacific Northwest. It resembles the early stages of California blight on peaches, and although sometimes considered to be a form of that disease, it is not positively known to be caused by the blight fungus. Failure to control it by repeated spraying with bordeaux mixture causes some investigators to believe that this disease is physiological or nonparasitic.

Under ordinary conditions California blight can be controlled in the orchard by spraying with 5–5–50 bordeaux mixture as soon as the leaves are off in the fall, or even before all of them are gone. When infection is common and severe because of warm, rainy weather, it may be necessary to spray again in the spring about a month ahead of blossoming time. Although nothing is known in detail concerning the effect of temperature on the disease, it is probable that very little enlargement of the spots will occur in transit if the fruit temperature is kept at 45° F. or slightly lower. (*16*, *17*, *21*, *30*, *31*, *45*, *60*.)

CLADOSPORIUM ROT (GREEN MOLD ROT)

(*Cladosporium* sp.[10])

In some seasons cladosporium rot is found very frequently on eastern markets on sweet cherries from California, Oregon, Washington, and Idaho. It is also found occasionally on peaches and plums from California. The decayed spot is usually small, often merely lining the wound around which it centers, with a thin layer of decayed tissue. Spots larger than 1 inch in diameter have not been found on peaches. A thin fluffy growth of white mycelium covers the spot and often extends somewhat beyond the decayed area. Later the aerial mycelium turns yellowish olive, with abundant spore production (pl. 6, *A*). The most striking feature of the decay is a hard cone-shaped core with its apex extending deep into the fruit. This core is gray to black, dry, and can easily be removed from the surrounding healthy tissue (pl. 6, *B*). Usually a thin layer of moist brown tissue lines the cavity in which it developed. Cladosporium rot very commonly follows cracking in cherries, and during two recent seasons when cracking was severe on fruit from the West, cladosporium rot followed in most of it.

[10] Not the fungus that causes scab of stone fruits.

A, Peach, spotting of skin after storage at 32° F. for 3 weeks and 70° for 3 days; *B*, peach, internal breakdown after storage at 40° for 2 weeks and 70° for 3 days; *C*, peach, hail injury: *D*, plum russet caused by thrips; *E*, plum, hail injury.

The fungus (*Cladosporium* sp.) associated with the decay belongs to a wide-spread group of organisms that live and sporulate abundantly on dead plant materials. Nothing is known of the orchard history of the specific organism causing the decay, but since the fungus is common on cherries from so many sections it is reasonable to expect that it is quite common in orchards and packing houses. The decay enlarges most rapidly at about 72° F. but develops slowly at temperatures as low as 34°. Frequently other organisms such as *Penicillium* species gain entrance and quickly destroy all primary symptoms.

Since the fungus enters the fruit only through breaks in the skin, it is apparent that a most important control measure is the prevention of wounds. All cracked cherries should be discarded before the packing is done. Rapid cooling after picking will retard the development of decay, but cannot be relied on to prevent it.[11]

COLD-STORAGE INJURY

In order to prolong the marketing season and avoid gluts, peaches are sometimes held in cold storage for periods ranging from a few days to 2 or 3 weeks or even longer. The shorter storage seems to have little or no bad effect on the appearance, texture, or flavor of the fruit. Prolonged storage, on the other hand, is usually harmful to all of these. The peaches lose their natural bright color, become dry and mealy, and eventually have an acid, astringent flavor. In addition they may develop break-down, the first indication of which may be either mealiness or a water-soaked appearance around the stone (pl. 4, *B*). In later stages the water-soaked regions become larger and turn brown. Brown spots may also develop on the skin (pl. 4, *A*).

Differences in the behavior of various lots in storage may be caused by differences in maturity. There are also varietal differences. It has been found, for example, that under comparable conditions Carman and Belle peaches develop storage break-down sooner than Elberta, and that none of these remain free of it as long as J. H. Hale and Late Crawford. The best storage temperature is from 31° to 32° F., and the maximum storage period without deterioration is not longer than 3 weeks, even for the best keepers (*28*).

When sweet cherries are held in cold storage for 2 or 3 weeks they sometimes become pitted. The pits are usually elongated in shape, of irregular outline, and brownish in color, especially on light-colored cherries (pl. 8, *A*). The larger spots are frequently underlain by a brownish discoloration of the flesh, in which small hollow spots may develop as desiccation proceeds.

This trouble may be followed by infection with decay organisms.

CRACKING

In an occasional season large amounts of cracking are found in cherries on the market. Although all varieties are susceptible, some are more apt to crack than others. The Bing variety cracks more

[11] Bratley, C. O. See footnote 5.

readily than the Lambert or the Napoleon, and the Montmorency less than any of the sweet varieties.

The cracking of cherries is usually caused by the wetting of the fruit with rain while still on the tree, although it may occur in transit if the fruit is covered with free moisture for long periods. It is also possible that excess absorption of water through the root system may cause the fruit to crack.

The extent of cracking induced by free moisture on the cherry depends on the concentration of the fruit juice, the turgor of the fruit, the temperature of the water, and the permeability of the skin. The fruit is most susceptible when fully mature, because at that time it becomes filled out and contains more sugar, so that the concentration of the juice is high. The underlying tissues swell rapidly and the skin is stretched and finally splits.

The location of the cracks on the fruit depends on the curvature of the surface, the most acute-angled part splitting first. Cracking usually occurs in 1 of 3 forms; in deep crescent or V-shaped cracks near or across the apex of the fruit, in deep straight slits along the body of the fruit (pl. 6, *E*, *F*), or in circles or semicircles in the stem cavity. Occasionally the tissue lining the cracks may dry, partially heal, and escape infection. Usually, however, secondary organisms such as *Cladosporium* species and *Alternaria* species enter and cause decay.

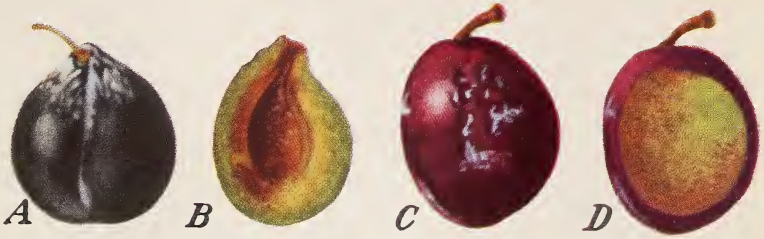
Both at the shipping point and on the market, peaches and plums are sometimes found showing cracks that are clearly not due to rough handling nor to pressure from a tight pack. These are sometimes called growth cracks. They are known to develop during or after rainy spells following very dry weather, and it is believed that they result from renewed growth of the fruit after the rain. Their significance, from the market point of view, lies in the fact that they sometimes become infected with decay fungi (*Rhizopus*, blue mold, gray mold) and may eventually spread infection to other fruits in the same package. (*29*, *30*, *55*, *65*.)

DROUGHT INJURY

Drought injury of the Italian Prune has been seen on the market in shipments from Idaho, Oregon, and Washington during seasons when the producing districts in those States had suffered from a shortage of rainfall or of irrigation water. It probably occurs in other prune-growing sections of the country. The injury is found in four distinct types, as follows:

(1) Gum spots ("gum pocket disease") associated with crescent-shaped scars, one-fourth to three-eighths of an inch long, on the surface of the fruit. The scars resemble curculio injury except that there is no egg-laying puncture beside them. In seasons of severe drought this type of injury is more common in the orchard than any of the others. It is not often seen on the market (pl. 8, *B*).

(2) Shriveling of the prune for a fourth to a third of its length, measuring from the stem end, accompanied by browning and blackening of the underlying flesh. The shriveling is probably due to withdrawal of water from the fruit by the leaves in times of water shortage, as is known to happen occasionally in apples, Valencia



A, *B*, *C*, *D*, Drought injury of prune; *E*, rhizopus rot of plum.

A, *B*, Cladosporium rot of cherry; *C*, brown rot of cherry; *D*, blue mold rot of cherry; *E*, *F*, cracking of cherry; *G*, brown rot of cherry.

oranges, and other fruits. There is no evidence that it can increase in transit or storage. This is the commonest type on the market (pl. 5, *A*).

(3) Shriveling on the cheek of the prune, with brown lines of injured tissue extending through the flesh. This type is less common and less serious than the stem-end shriveling (pl. 5, *C*, *D*).

(4) Browning of the cells lining the pit cavity. This type of injury has no exterior manifestation, but if severe it injures the eating quality of the fresh fruit, because the affected flesh has a bitter, disagreeable taste. The browning also makes buyers doubtful about the carrying quality of any lot so affected. There is no experimental proof, however, that such lots are any more likely to deteriorate in transit than those that are free of the browning (pl. 5, *B*).

The only suggestions that can be made regarding control are that (1) in irrigated sections no lack of proper irrigation should be allowed to occur if water is available; (2) in any section, no soil conditions that have the effect of drought should be tolerated if they can be prevented by proper soil management; (3) weaker growing stocks such as Agen should not be top-worked with vigorous growers like the Italian Prune, since this practice is known to result in a high percentage of drought injury. (*34*.)

FRUIT FLY INJURY

(*Rhagoletis cingulata* Loew and *R. fausta* O. S.)

Cherries infested by fruit fly maggots are misshapen and undersized; they turn red ahead of the main crop, and frequently have one side of the fruit shrunken, partly decayed, and attached to the pit (pl. 11, *A*). The fruit fly larvae, which are often still in the fruit when it is marketed, are yellowish-white, footless maggots, about one-fourth inch long when fully developed. These maggots are pointed at the front end, and there is no well-defined head. They may be readily distinguished from larvae of the curculio, which have brownish heads, and from larvae of the oriental fruit moth and the peach twig borer, which are pink or brown in color and have legs.

Two common species of fruit flies infest cherries—the cherry fruit fly (*Rhagoletis cingulata*) and the black cherry fruit fly (*R. fausta*). Details concerning their distinguishing characteristics and their life histories are given in the references cited below. For the purposes of this discussion, however, the differences between the species are unimportant.

The cherry fruit flies are found in most cherry-growing districts in the northern part of the United States. In addition to cherries, they sometimes infest plums, prunes, and also pears.

These insects may be controlled by spraying the trees with lead arsenate late in June or early in July, but this leaves a residue which must be removed before the cherries are marketed or consumed. More detailed information on control may be obtained from State experiment stations or extension service or the United States Department of Agriculture.

Many of the wormy fruits containing the larvae of either the plum curculio or the cherry fruit flies can be removed by placing infested lots in water and skimming off the fruits that float, which are usually the ones containing worms. The skimming should be done immediately after the fruit is immersed in water, otherwise some of those that are infested are likely to become water-logged and sink to the bottom with the sound ones. (*41*, *43*, *54*.)

GRAY MOLD ROT

(*Botrytis* sp., probably *B. cinerea* Pers.)

Gray mold rot is one of the common rots of cherries found on the market and occurs on fruit from all large producing sections. It is found occasionally on plums and peaches. In early stages it is characterized by a light-brown spot on the skin covered with extensive, delicate, aerial hyphae, and underlain by rather firm, watery, brown affected tissue. As the lesion enlarges, the fungus growth becomes more prominent (pl. 2, *B*). If the fruit is held under fairly dry conditions, abundant sporulation occurs in the form of barely visible grayish-brown heads on short hyphae of the same color; if under moist conditions, such as are often found in a box of cherries, abundant white mycelium is formed that sometimes covers the entire fruit. The skin near the margin of the lesion slips easily under pressure from the finger, as in rhizopus rot, but the decayed tissue does not have the odor characteristic of rhizopus rot. In fact, gray mold rot has no definite odor.

Gray mold rot is induced by *Botrytis* sp., probably *B. cinerea*, which produces decay in a wide variety of fresh fruits and vegetables from many producing sections. Although the organism usually enters through breaks in the skin of the fruit, it occasionally spreads from fruit to fruit through apparently sound epidermis, as evidenced by the fact that a nest of several decayed cherries is sometimes found centering around a cherry in an advanced stage of decay. The rot develops most rapidly at temperatures between 65° and 75° F., but the usual temperatures in iced refrigerator cars are not low enough to prevent affected areas from enlarging, since some development occurs at temperatures as low as 32°.

Careful handling during picking and packing operations and prompt disposal of culls and rotted fruits are the most valuable control measures known. It has been found that cherries given the ordinary commercial handling may show almost four times as much gray mold rot after a 15-day transit period as cherries handled very carefully. Precooling the fruit quickly after picking is essential for control, since the decay develops rapidly at temperatures found in the upper part of nonprecooled cherry shipments in a refrigerator car. (*38*, *39*.)[12] (See p. 8.)

HAIL INJURY

Hail injury consists of irregular, more or less sunken spots which often have dried-up fragments of the skin and flesh around the edges or on the surface (pl. 4, *C*, *E*). These spots differ from curcu-

[12] BRATLEY, C. O. See footnote 5.

lio injury in being larger and in showing little or no gummy exudate and no trace of larval burrows underneath. Because of the way in which they are produced, they generally occur on only one side of the fruit, whereas those due to curculio may be found on all sides. Injury by fruit beetles is sometimes mistaken for injury by hail or by curculio, but can be distinguished from either by the smooth flat layer of wound cork that lines the cavities. Early hail injury is distinguishable from damage by birds or grasshoppers because the latter occurs late in the season and hence is not likely to heal over before the fruit arrives on the market. Fruits struck by hail late in the season are usually so severely damaged that they do not reach the market.

INTERNAL BROWNING

Internal browning not caused by cold storage is a condition occasionally found in peaches, which is exhibited as a localized or a general browning of the flesh. Sometimes it develops first in the flesh next to the stone. It seems to be characteristic of certain varieties, notably the Carman, although there is some evidence that it is connected with soil and weather conditions. The browning bears some resemblance to cork in apples, which may mean that it is brought on by drought.

Internal browning is seldom found on the market.

LEAF CURL

(*Exoascus deformans* (Berk.) Fckl.)

Leaf curl as a disease of peach and nectarine fruits occurs chiefly in humid sections of California and the Pacific Northwest and in the territory around the Great Lakes. It is not often seen on the market.

The commonest and most destructive form of leaf curl is well described by the name. It consists of a puckering and curling of the leaves, which begins to develop soon after they unfold in the spring. As the season progresses the curling becomes more pronounced and the affected tissues become thickened and turn yellow or red and finally show a characteristic silvery bloom (spores) on the upper surface. Diseased leaves eventually die and drop from the tree. If the attack has been severe the entire tree may be defoliated.

The flowers and young fruits are sometimes affected, but they usually fall early in the season and hence are not often seen. Maturing fruits, however, are often attacked, and as a result large wartlike protuberances appear on the surface, or the lesions may occur as depressed lacy markings on the undistorted surface of the fruit. In either case the diseased tissues are usually blotched or streaked with red, and those most severely affected may develop deep cracks (pl. 1, *C*, *D*).

Leaf curl is caused by the fungus *Exoascus deformans*. This fungus grows among the cells of the leaves and epidermis of the fruit, stimulating them to abnormal growth that produces the curled, distorted condition described above. The disease is carried over winter by spores that lodge among the bud scales and germinate in

moist weather in the spring, infecting the young leaves as they are produced.

Leaf curl is commonest and most severe near large bodies of water or along river valleys where cold wet weather occurs in the spring, affording conditions favorable to the growth of the fungus.

Leaf curl can be controlled by one thorough spraying with a fungicide—bordeaux mixture, copper sulphate, or lime-sulphur—before the buds begin to swell in the spring. (*30*, *31*.)

ORIENTAL FRUIT MOTH INJURY

(*Grapholitha molesta* Busck)

Eastern peaches are quite subject to attack by larvae of the oriental fruit moth, which tunnel through the flesh, leaving broken-down and decaying areas behind them (pl. 10, *C*). The entrance hole is often very inconspicuous and easily overlooked, especially when the worm entered through the stem or next to it. In such instances the peach may appear perfect externally, even though rather completely broken down internally. In other cases, when entrance occurs through the side, the entrance point may be marked by the presence of more or less frass and gum.

The debris left behind by the worms as they burrow through the peach is usually somewhat drier and of a more definite granular form than that left behind by the curculio (p. 17). As the area decays and gum is produced, however, the injury by the two species is difficult to distinguish.

The fruit moth larvae are about one-half inch long and are pink when full grown, whereas those of the plum curculio, often found in the same peaches, are white or faintly yellow. Larvae of the fruit moth have legs; those of the plum curculio are legless.

The fruit moth occurs in practically all peach sections east of the Rocky Mountains and attacks nearly all kinds of fruits. It shows a distinct preference, however, for peaches and quinces. The degree of infestation varies with the season of ripening, the later peaches being in general more heavily infested. Early in the season the larvae prefer to feed on the twigs, but as these harden and the fruits mature, the later generations feed more extensively in the fruit. Normally the varieties earlier than Elberta largely escape infestation. The Elberta may be heavily infested, especially if the twigs have hardened and a brood of fruit moth larvae happens to be hatching just at ripening time. Varieties of peaches later than Elberta are usually very severely attacked.

The oriental fruit moth has been found extremely difficult to control and does not yield to insecticide treatments that have been found effective for many related species of insect pests. A little reduction in infestation may be accomplished by spring cultivation, by the use of paradichlorobenzene as practiced for the control of the peach borer, and by the prompt destruction of cull fruit. The Bureau of Entomology and Plant Quarantine has given special attention to the introduction and establishment of numerous species of parasites of the fruit moth. Certain eastern forms have been recolonized in other infested peach sections, and foreign parasites are being brought in and are being established as rapidly as possible.

The activities of the parasites are already resulting in a lowering of the general level of infestation in the areas that have been infested the longest time. In the absence of effective insecticide treatments, special attention is also being given to the use of bait traps for the control of the fruit moth, in an effort to develop control measures that can be applied by the practical grower. (*15*, *22*, *26*, *41*, *46*, *54*, *61*, *63*, *64*.)

INJURY BY PEACH TWIG BORER

(*Anarsia lineatella* Zell.)

Peaches and other stone fruits are sometimes found to contain larvae of the peach twig borer, which produces an injury that cannot be distinguished readily from that caused by the oriental fruit moth (p. 16). As with the latter species, the entrance hole may be very inconspicuous, and the injury is usually the most serious in late varieties of peaches, since the larvae of the early broods feed on the young growth, and turn their attention to the fruit as the shoots harden.

The twig borer larvae vary in color from a deep pink to a dark brown and are readily distinguished from those of the oriental fruit moth and of the plum curculio.

In the Rocky Mountain and Pacific Coast States this is the only worm commonly found in peaches; east of the Rockies injury by the curculio or the oriental fruit moth is usually the predominant type.

The peach twig borer may ordinarily be controlled by spraying with dormant-strength lime-sulphur as the buds are pushing out in the spring and begin to show pink. The addition of lead arsenate to the lime-sulphur increases the effectiveness of the treatment. On apricot trees, which are especially susceptible to injury by lime-sulphur, nicotine sulphate with soap, or lead arsenate with bordeaux mixture, may be substituted for the lime-sulphur. In case of severe infestations, the fruit may be protected from the summer broods of worms by spraying with lead arsenate. Because of danger of excessive spray residues, however, this treatment should not be applied too close to harvest time. As noted elsewhere in this publication, excessive residues of arsenate of lead and other poisonous substances must be removed before the fruit is marketed or consumed. (*41*, *43*, *54*.)

PLUM CURCULIO INJURY

(*Conotrachelus nenuphar* Hbst.)

In the eastern half of the United States the plum curculio is very largely responsible for the presence of wormy peaches on the market, as well as peaches that are scarred or distorted even though no worm is present inside. The plum curculio is a very general feeder on all kinds of fruits, and its work is especially serious on peaches, plums, and cherries.

Early in the spring the beetles emerge from hibernation quarters and make their way to fruit trees, beginning about the time these

are in bloom. They puncture the skin of the newly formed fruit for the purpose of feeding and also for laying their eggs. Frequently each egg puncture is partially surrounded by a crescent-shaped slit, which persists on smooth-skin fruits, such as plums, but generally loses its shape on the growing peach. The egg-laying and feeding activities of the adult curculios result in more or less scarring, and in extreme cases in a distortion, of the fruit (pl. 10, *A*).

The larvae tunnel through the flesh of the fruit and cause a more or less complete disorganization around the pit (pl. 10, *B*). The curculio larva is a white or yellowish-white grublike worm about three-eighths inch in length when full grown. It may be distinguished from other worms found in stone fruits by the fact that it is legless and lies in a curled position. In the adult form the curculio is a brown snout beetle about three-sixteenths inch in length.

The punctures caused by the curculio adults in feeding or in laying their eggs frequently serve as entrance points for brown rot (p. 5), the spores of which may be carried on the insect's body or by the wind. The control of brown rot is therefore closely related to the control of this insect.

The program for controlling the curculio involves a number of practices, including timely spraying with lead arsenate, and, in regions where a second brood occurs, the avoidance of excessively heavy applications of material in the final spray, this application to be completed not later than 4 weeks preceding the probable date of harvest; jarring the trees in the spring to capture the beetles when they appear from hibernation, and, especially in southern areas where a second brood occurs the same season, the removal and destruction of early dropped fruits; and thorough cultivation early in the summer while the insect is in the ground in the delicate pupal stage. More detailed information on this subject may be obtained from the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture, or from the State experiment station or extension service. As noted elsewhere in this publication, excessive residues of arsenate of lead and other poisonous substances must be removed before the fruit is marketed or consumed. (*41*, *54*, *61*, *62*.)

POWDERY MILDEW

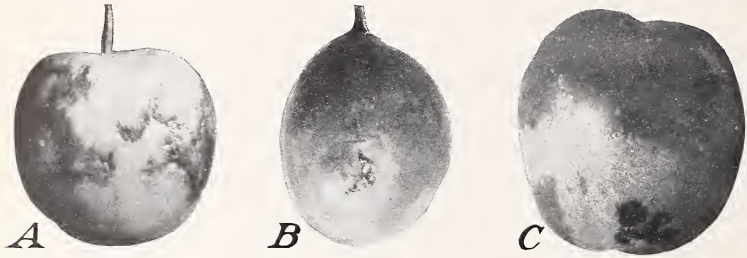
(*Sphaerotheca pannosa* (Wallr.) Lév. var. *persicae* Wor.)

Peach powdery mildew occurs in most of the important peach sections of the United States but is not often destructive in any of them. The susceptibility of varieties is not marked, though in the East the Early Crawford, Late Crawford, and Denton usually suffer more than other varieties. The disease has recently been reported as occurring on nectarines in Oregon.[13]

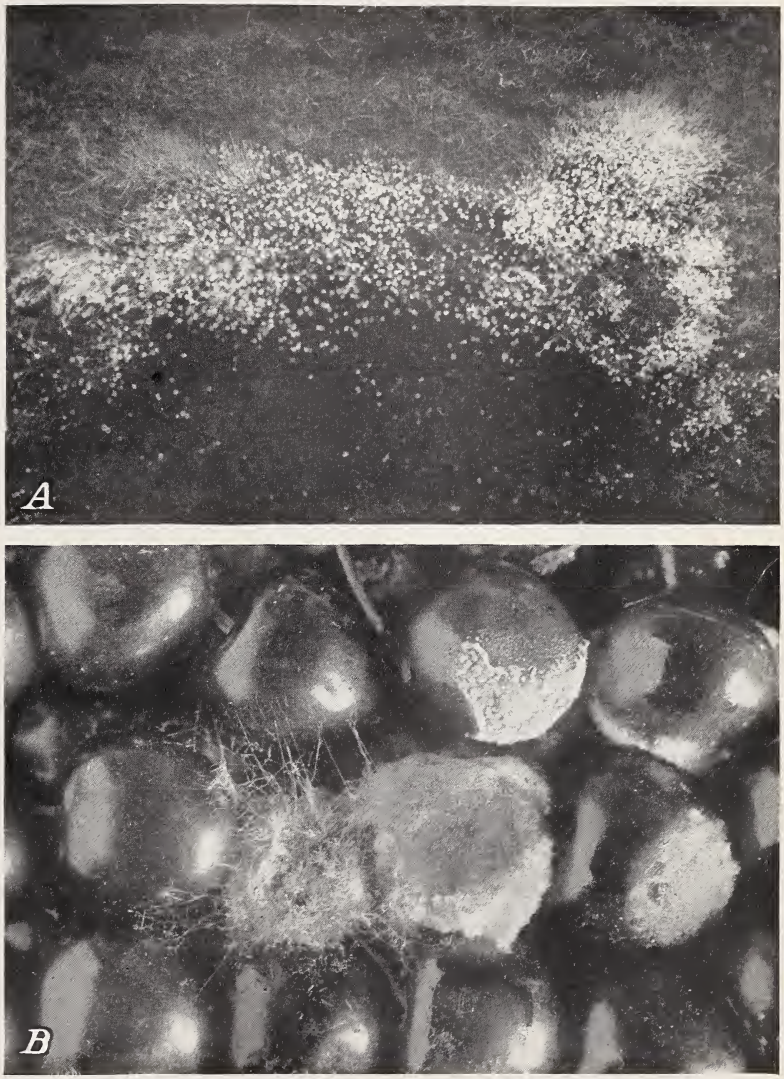
The fungus attacks leaves, twigs, and fruits, producing on all of these the characteristic irregular white patches of mold, composed of the mycelium and spores of the fungus. Underneath these patches on the fruit the skin takes on a brown or dead color; the underlying flesh is rather hard and has a dark, water-soaked appear-

[13] KIENHOLZ, J. R. POWDERY MILDEW (SPHAEROTHECA PANNOSA) ON NECTARINE IN HOOD RIVER, OREG. U. S. Dept. Agr., Bur. Plant Indus., Plant Disease Reptr. 19: 200. 1935. [Mimeographed.]

Rhizopus rot of peach.



A, Cherry, cold-storage injury; *B*, gum pocket on plum, a form of drought injury; *C*, plum frost russet; *D*, brown rot of plum.



A, Sporangia of *Rhizopus* on surface of rotting peach, enlarged about 10 diameters; *B*, brown rot and rhizopus rot of cherry, slightly enlarged.

A, Scarring of peaches which has resulted from the egg-laying and feeding activities of the plum curculio; *B*, peach cut open to show injury by plum curculio, larva in typical curled position; *C*, peach cut into to show injury by oriental fruit moth, enlarged about 4 diameters.

ance which usually extends inward at least half the distance from the skin to the stone.

For control of the disease it is necessary to spray with lime-sulphur or make applications of sulphur dust. For further details the United States Department of Agriculture or the State experiment stations should be consulted. (*67.*)

RHIZOPUS ROT

(*Rhizopus nigricans* Ehr. ex Fr., and possibly other *Rhizopus* species)

OCCURRENCE, SYMPTOMS, AND EFFECTS

In peaches attacked by rhizopus rot, affected tissues are light brown in color, and by the time the peach is well decayed the flesh is soft though not mushy. At this stage the characteristic coarse white fungus growth and white, gray, or black spherical sporangia or spore-bearing bodies appear, which are easily distinguished from the yellowish-gray, spore-bearing tufts of the brown rot fungus (pl. 3, *A*, *B*, *C*, *D*; pl. 5, *E*; pl. 7; pl. 9). In rhizopus rot the skin slips easily from the diseased flesh, whereas in brown rot it usually clings tightly.

In apricots, rhizopus rot has much the same symptoms as in peaches. In plums, prunes, and cherries a soft, leaky condition is produced that may or may not be accompanied by slight browning (pl. 5, *E*). In all of these fruits a strongly acid odor is usually noticeable when the rot becomes well advanced. In peach shipments from the East and South, rhizopus rot is usually about as common and destructive as brown rot; in shipments from Colorado and other Western States it is frequently the only rot seen.

On cherries the affected areas are at first water-soaked, slightly darker than healthy tissue, and very tender. In late stages the entire fruit is broken down into a red liquid mass covered with abundant coarse mycelium (pl. 7) which early turns to dull black. If slight pressure with the palm of the hand is exerted on the top of a cherry pack containing some of this decay, the face will sink and red juice will drip from the lug. Most of the unsightly red staining of cherry lugs is due to the release of juice because of this decay.

CAUSAL FACTORS

The danger of attack by *Rhizopus* in transit is greatly increased by the presence of skin breaks and moisture. Whether or not the fruit is attacked depends almost entirely on the temperature at which it is held. For this rot the critical temperature or danger point is 50° F. Two or three degrees below this the product is fairly safe, provided the fruit is cooled to 50° or below soon after it is picked and the temperature during all of the transit or storage period does not exceed 50°. During the usual number of days in transit for most peach shipments, *Rhizopus* can produce little or no damage at 50° and none at 45°. Whether it can make any start whatever at 45° seems to be determined mainly by the maturity of the fruit. At that temperature it can produce visible rot spots in 6 days on ripe peaches, but not until the end of 12 days on green ones. For this reason delay in cooling, due either to the loading of warm fruit or to failure to ice cars promptly, is always hazardous,

because it gives opportunity for the rot to get started and so increases the probability of damage. By giving the fungus a longer time in which to work, the delay aggravates unfavorable conditions that may already exist or may cause others to arise that would not have occurred if the car had moved on time.

CONTROL MEASURES

Precooling does much to obviate the danger of attack by *Rhizopus* and other fungi, as is shown by tests made in the Northwest with prunes and cherries. Cherries precooled, then held in an iced car, showed after 5 days of such storage 2.2 percent of decay; after 10 days, 6.6 percent; and after 15 days, 9.8 percent. Similar lots similarly stored but not precooled showed at the end of 5, 10, and 15 days, respectively, 3.2, 9.2, and 13.5 percent decay. Results equally striking or even more so were obtained with prunes and with both prunes and cherries in tests that compared the effect of delayed and immediate shipment and delayed and immediate precooling. The addition of salt to the ice in the bunkers hastens cooling, although for precooled fruit the quantity added at any one time probably should not exceed 3 percent by weight of the ice supplied at that time, in order to avoid danger of freezing the fruit. If the fruit has not been precooled, 5 per cent of salt may be used. (*3*, *10*, *11*, *28*.)

RUSSETING

Russeting occurs on practically all varieties of plums and prunes from all producing sections but is most common on Tragedy plums and Italian Prunes from California and the Pacific Northwest.

It is exhibited by irregular, rough russeted spots anywhere on the surface of the fruit. These may be caused by the syneta leaf beetle (pl. 11, *C*, *D*), by thrips (pl. 4, *D*), by frost (pl. 8, *C*), and possibly also by other weather conditions. Injury by the syneta leaf beetle is usually deeper and rougher than that caused by thrips, because the beetle chews off portions of the skin, whereas the thrips merely rasps the epidermis away and laps up the juice that exudes. On cherries the leaf beetle injury may result in severe distortion of the fruit (pl. 11, *D*). Thrips injury is similar to that caused by frost, but the surface of the affected area has a finer texture in the former than in the latter.

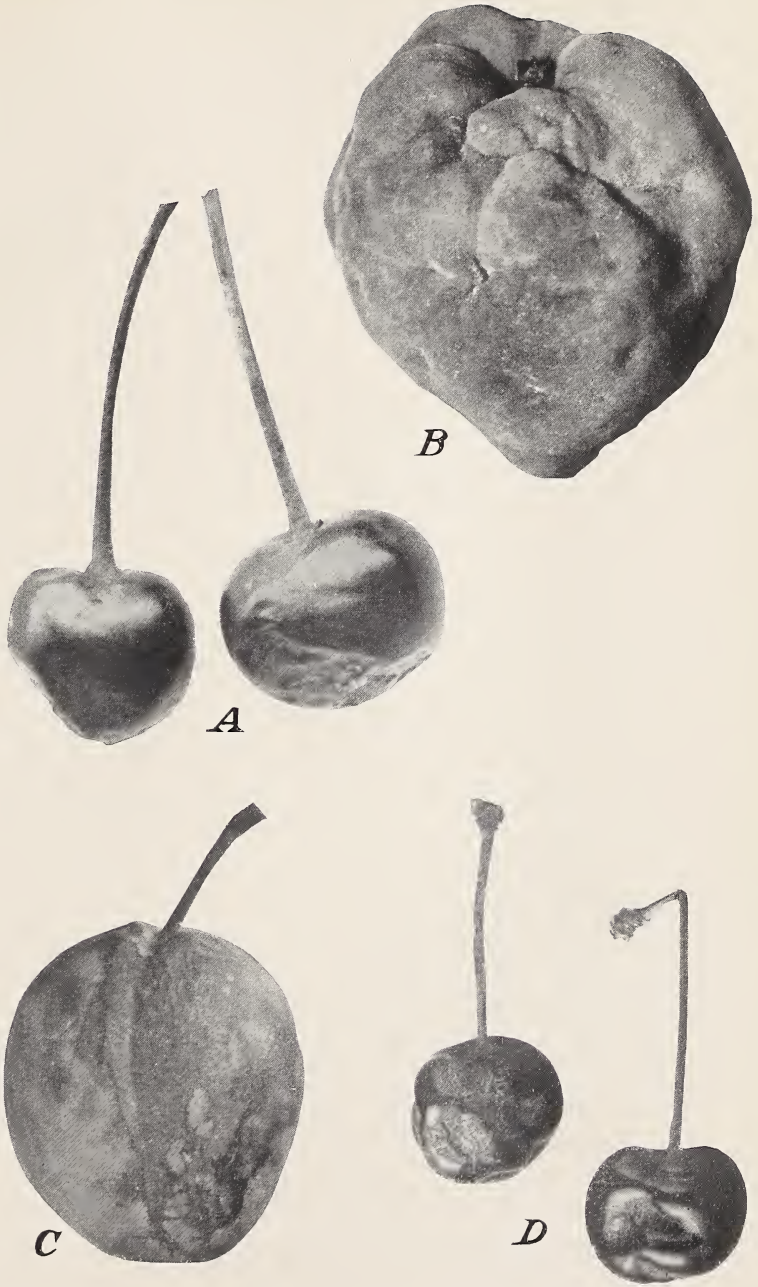
RUST

(*Tranzschelia pruni-spinosae* (Pers.) Diet.)

The rust disease caused by *Tranzschelia pruni-spinosae* (Pers.) Diet. is reported as occurring on all stone fruits except nectarines. It is usually of very little economic importance, but occasionally (as in California in 1925, 1926, and 1927) makes a rather wide-spread attack and causes heavy loss.

The fungus causes diseased spots on the leaves, fruits, and twigs, the latter being the principal source from which spores come in the spring that spread the rust again through the orchard.

Infected spots on the fruit are water-soaked and dark green at first; later they become deep yellow. In this late stage the spots are markedly sunken because of the arrested growth of the flesh under-



A, Cherries shrunken as a result of infestation by cherry fruit flies; *B*, ripe peaches, injured when small by sucking bugs; *C*, syneta leaf beetle injury on plum; *D*, syneta leaf beetle injury on cherry.

neath them. The disease as observed in California occurs almost exclusively on clingstone peaches, and the tough, leathery tissues underneath the rust spots interfere with peeling, thus making the fruit undesirable for canning.

The spread of rust in the orchard is favored by rainfall and high humidity. Laboratory studies and field tests indicate that spraying or dusting with some form of sulphur is of value as a means of controlling the disease. (*25*, *36*.)

SCAB

(*Cladosporium carpophilum* Thüm.[14])

OCCURRENCE, SYMPTOMS, AND EFFECTS

The fungus disease known as scab originates in the orchard. It makes a general attack there on leaves, twigs, and fruit, but is of most importance on the fruit. Scab occurs in practically all peach-growing sections of the United States except Washington and Oregon, but is more serious east of the Rocky Mountains than west of them. It is rare in central Georgia but quite prevalent in the so-called "mountain" peach orchards of the Blue Ridge and Allegheny Mountains. Plums, nectarines, cherries, and apricots are sometimes affected, but much less seriously than peaches.

Of the diseases of the fruit of the peach, scab is second only to brown rot in economic importance. In some seasons the loss in certain sections has been estimated at 10 percent of the crop, while for the eastern United States the average annual loss is often put at the same figure.

On the leaves scab is characterized by brown spots in which the tissue dries up and finally drops out, leaving circular holes. On the young twigs it appears as roughly circular yellowish-brown blotches with a dark gray to bluish border. The fungus here usually affects only the outer layer, but may girdle and kill the twig.

On the fruit, in the case of mild infection, scab occurs as small circular spots, olive green to black in color, and distinct from one another, which affect only the skin and a shallow layer of flesh underneath (pl. 1, *B*). These spots may occur anywhere on the fruit, but are usually confined to the side that is uppermost as it hangs on the tree. When infection is severe the spots coalesce to form large dark sooty areas, and the fruit becomes dwarfed or misshapen because of the formation of a protective layer of cork under the diseased area. In such areas cracks frequently develop and a way is opened for infection by the brown rot fungus, by *Rhizopus*, or by blue mold.

CAUSAL FACTORS

Scab is caused by the fungus *Cladosporium carpophilum* Thüm. The fungus overwinters chiefly in diseased spots on twigs, and under favorable conditions begins to produce conidia soon after the blooming period is past. These conidia are the means by which the fungus is spread to fruits, leaves, and other twigs. They are produced in greatest abundance in wet weather and are believed to be dissemi-

[14] Not the fungus that causes cladosporium rot.

nated almost entirely during rains by the splashing of water from twig spots onto fruits, leaves, and other twigs. They are probably distributed to some extent also by birds, insects, and wind. The disease is more prevalent in wet than in dry seasons, and in sections where the spring and early summer are moist than where they are dry.

CONTROL MEASURES

Scab is strictly an orchard disease and does not develop or spread in transit or storage. It can be controlled by spraying or dusting with some form of sulphur. For detailed information to fit local conditions the United States Department of Agriculture or the State experiment stations should be consulted. (*30*, *31*, *35*, *37*, *50*, *56*, *58*, *61*.)

SPLIT PITS

Peaches and plums of all commercial varieties are occasionally found that have split pits. Affected fruits can sometimes be recognized (1) by their being flattened somewhat at the blossom end or at least more nearly spherical than usual, or (2) by a visible crack in the flesh and the upper end of the stone, in the stem cavity. Usually the fruit must be cut before a positive diagnosis can be made. Infection with blue mold, gray mold, or *Alternaria* sometimes occurs on the seed or pit, but is not often found to have spread to the surrounding flesh.

In peach-growing sections east of the Rocky Mountains split pits are found generally on trees that have been partly girdled by borers or winter injury, or are affected by some other condition that interferes with the downward movement of the elaborated food from the leaves. Investigations in California have indicated that split pits are closely associated with conditions that cause an increased rate of growth of the fruit. Growers in that State have observed that years of very large sizes in the peach crop are years of high percentages of split pits. (*8*, *9*, *19*, *47*).

SPRAY INJURY

Spray injury appears on the side or at one end of the fruit as dry, browned, or blackened areas which are frequently accompanied by severe cracking of the skin and the underlying flesh. As it commonly occurs it is nothing more than a severe blemish, although on account of the cracks it may open a way for the entrance of decay fungi, particularly the brown-rot fungus.

The condition here described is most often caused by the arsenate of lead solution used for the control of the curculio, and is usually confined to orchards where the solution used was too strong or was applied in such a way as to drench the fruit. It may also be caused by making the application in bright sunlight during extremely hot weather.

The use of bordeaux mixture, self-boiled lime-sulphur, or other sprays containing lime on sweet cherries is likely to reduce the size of the fruit, and heavy applications shortly before harvest may cause the fruit to become more or less shriveled or wilted.

INJURIES CAUSED BY SUCKING BUGS

Peaches and other stone fruits are sometimes pitted, dimpled, or scarred, or more or less distorted, as a result of feeding by sucking bugs of various species early in the season, when the fruits were small (pl. 11, *B*). The dimplelike pits caused by these sucking insects are quite characteristic. The more severe injuries, however, take the form of scarred or corky areas which cannot be distinguished from those produced by the plum curculio. The feeding takes place for the most part in the spring or early in the summer, shortly after the adult bugs leave their hibernating quarters.

In the southeastern part of the United States injury of this nature is caused by a member of the squashbug family, *Leptoglossus oppositus* Say. The southern green stinkbug (*Nezara viridula* L.) causes a similar injury. In the Northwest the tarnished plant bug (*Lygus pratensis L.*) often causes a dimpling, scarring, and distortion of peaches and other fruits. The same insect and several species of the larger stinkbugs cause the same type of damage in the Middle West, where the injury is referred to locally as "cat-facing." Other stone fruits are sometimes injured in the same way.

The control of these sucking bugs is difficult. The usual contact sprays are ineffective, even against the few active insects actually hit by the spray liquid. The injury is always worst in cover-cropped orchards or orchards that are permitted to become weedy, since most of the species of bugs involved breed during the season on herbaceous plants in and near the orchard. The elimination of cover crops or weeds, when this does not conflict with best orchard practice, is helpful in reducing the amount of injury. (*43*, *61*.)

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